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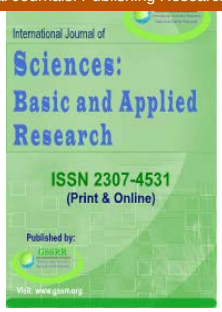

Challenges in the Diagnosis of Acute Arterial Ischemic Stroke (AIS) in Children in Saudi Arabia: Retrospective Study

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Abstract

Diagnosis of arterial ischemic stroke (AIS) in children is a challenge to many clinicians. Determining the time between symptom onset and diagnosis and identifying the factors that contribute to the delay in diagnosis will help target them and provide an early and effective therapeutic strategy. A retrospective study was conducted on children diagnosed with AIS admitted to Al-Yamamah Hospital, Riyadh, Saudi Arabia from January 2000 to December 2012. Data collected included the initial symptom of AIS, time from initial symptom to hospital arrival, first medical examination; initial imaging studies, and diagnosis. A total of 51 children with AIS were studied. The median pre-hospital delay (symptom onset to hospital arrival) was 10 hours (interquartile range: 2.8-13.2 hours), in-hospital delay (symptom onset to diagnosis) was 5.5 hours (interquartile range: 2.3-20.4 hours). Younger age of the patient, lower Pediatric National Institute of Health Stroke Scale score, absence of sensory-motor deficits, absence of seizures, lack of consciousness alterations, presence of heart diseases, lower response of parents to child's condition, use of private transportation, delayed referral from private clinics, length of procedures performed in the Emergency Department (ED), and lower sensitivity of CT scans are predictors of longer time to AIS diagnosis. We have identified several pre-hospital and in-hospital predictors of delayed AIS diagnosis. Managing these factors may reduce significantly the timing of diagnosis and optimize the management of children with AIS.

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1. Introduction

Pediatric stroke is a major cause of disability and long-term neurological morbidity [1]. In neonates, it occurs between 28 weeks of gestation and 28 days of postnatal age with an incidence of 1 in 4000 live births [2]. In children, it occurs between 29 days and 18 years of life [2, 3], with an incidence of 2 to 13 cases per 100,000 children per year [4]. The recurrence rate of childhood stroke is between 6 to 40% [5, 6]. The authors in [7] reported a death rate of 20% in the stroke population studied (n = 72), whereas death occurred more frequently in children with recurrent stroke (40%) than those that suffered from a single event (16%).

The most common causes of pediatric stroke are intracerebral hemorrhage and ischemic stroke [8]. It has been reported that 50% to 85% of infants and children, who present Arterial Ischemic Stroke (AIS), have long-term neurologic deficits, thus, critically affecting their potential development [9-13], reduction in quality of life in more than 50%, and death in 12% of the cases [2, 14]. Therefore, early diagnosis and treatment is important. In spite of that, frequent delay in the diagnosis was reported in many studies [15-19]. The time to establishing a diagnosis of AIS in children is more than 24 hours on average; the time span is even longer in neonates [15-19].

The delayed diagnosis has been attributed to several factors. First, the incidence of AIS is low, ranging from 0.6 to 7.9 per 100 000 children per year [20]. Second, in young children, AIS usually presents with seizures, irritability, altered consciousness, or hemiparesis, which physicians frequently attributed to stroke-mimickers such as migraine, encephalitis, tumors, postictal Todd paralysis, and focal intracranial lesions, such as hemorrhage, tumors, or demyelination which can account for up to one fifth of cases presenting with stroke-like symptoms [21]. Another contributing factor to the delay and inaccurate diagnosis of pediatric AIS is the initial neuroimaging tests. Although the computed tomographic (CT) scan is the standard initial neuroimaging test for patients with acute neurological presentations, it may not detect the early signs of infarction in the majority of the patients (52–84%), as it is normally performed within 6 hours from the onset of symptoms in only a minority of stroke patients [18, 22]. Furthermore, most parents are unaware of possible stroke symptoms in their children [23].

These factors not only affect the individual, but also are associated with a significant cost to their caregivers and to society. The estimated annual cost of acute pediatric stroke care in the United States is $42 million. The mean cost of acute hospital care for patients aged 3 months to 20 years with any new stroke is more than $20,000 per patient, and for patients with ischemic stroke, $15,003 [24]. Therefore, the challenge is to identify the length of delay in AIS diagnosis, and the contributing factors. Several reports from different countries and health systems have confirmed the delay, and also identified the factors that influence the early diagnosis [15-18]. This study aimed to determine the time elapsed between clinical onset and diagnosis of AIS among infants born in Riyadh, Saudi Arabia and to identify factors that influenced the time to diagnosis.

2. Materials and Methods

We retrospectively reviewed the medical records of children aged 1 month to 15 years with confirmed diagnosis of AIS from 2000 to 2012, at the Al-Yamamah Hospital, which provides pediatric neurological care in Riyadh, Saudi Arabia. The study protocol was reviewed by the chair of the hospital's Research Ethics Committee and was approved without the need of a full ethical review.

The following information was extracted from patient medical records: demographic data (gender, age at the time of stroke); initial symptom of AIS (e.g., decreased consciousness, headache, seizures, other sensory motor deficits, fever, aphasia, ataxia); location of the first medical examination (general medical unit, emergency department, general pediatric private clinic); time from initial symptom to first medical examination; time to initial imaging studies; known risk factors in the child's history (e.g., infections, heart disease, head injury and migraine); treatment; time to final diagnosis; and outcome. The data regarding onset of symptoms and method of transportation were retrieved from the Emergency Medical Services (EMS) records and history at admission. The time of imaging was retrieved from the CT and Magnetic Resonance Imaging (MRI) reports.

AIS was defined as (1) an acute neurologic deficit lasting $\geq$ 24 hours; and (2) parenchymal infarction on neuroimaging scans. Pediatric National Institute of Health Stroke Scale (pedNIHSS) score was calculated based on data obtained from the medical charts. The pedNIHSS score is a strong predictor of long-term outcome after acute stroke because it reflects several brain functions including consciousness, vision, sensation, movement, speech, and language. The score values range between 0 (no symptoms) and 42 (most affected) [25]. The inclusion criteria were children aged 1 month to 15 years at the time of AIS, with radiologic confirmation of AIS. Exclusion criteria were sinovenous thrombosis and hemorrhagic stroke subtypes, systemic vasculitis, other non-AIS disorders associated with focal deficits, recurrent strokes, unclear neuroimaging, and incomplete medical records.

The primary outcome was the length of delay in AIS diagnosis defined as 6 or more hours elapsed between time of onset of AIS symptoms and the time to diagnosis. Because of the imprecision in reporting the onset of symptoms, epochs of time were used: <6 hours, 6–12 hours, 12–24 hours, and 24–48 hours, analogous to previous studies [26-29].

2.1. Statistical Analysis

All data were analyzed using SAS statistical software package Version 9.4 (SAS institute, Cary, NC, USA). The following predicted factors of delay were selected from the subject's medical files based on their relevance to the aim of the study, and also based on our review of previous studies with similar aims conducted in different countries [8, 9, 11, 15-18, 27, 30, 31]: gender, age at the time of stroke; initial symptom of AIS (e.g., decreased consciousness, headache, seizures, sensory motor deficit, fever, aphasia, ataxia); pedNIHSS; initial neuroimaging studies; type of contact with the medical sector; action of parents; transportation; and known risk factors. Median and interquartile ranges are reported because the data distribution was skewed. Comparisons of nominal variables were performed with Pearson's $\chi 2$, and Wilcoxon rank sum test was used for continuous variables. To identify factors related to the length of delay in diagnosis, one-way analysis of variance was conducted for categorical variables, and linear regression was conducted for continuous variables. If the

predicted factors showed some level of significance on univariate analysis, multivariate analysis was then performed. Statistical significance was defined as $p < 0.05$.

3. Results

A total of 58 children with acute AIS were identified; 7 subjects were excluded because of inadequate documentation of diagnosis timing.

3.1. General characteristic of subjects

The general characteristics of our study population and clinical presentation are shown in Table 1. A total of 33 boys and 18 girls were included in the study. The median age was 4.2 (range 0.2 to 14.8) years for out-of-hospital patients and 2.7 (range 0.5 to 5.3) years for in-hospital patients. At the time of stroke onset, 66% (34/51) of subjects were under 5 years of age; 24% (12/51) were between 5.1 and 10 years of age; and 5% (10/51) were over 10 years of age (Table 1).

3.2. Clinical data

The initial clinical presentation in out-of-hospital patients reported by parents/caregivers was sensory-motor deficits (hemiparesis) in 50% (19/38), which was confirmed by clinical examination in 87% (33/38) of the cases. Other associated presentations include aphasia in 24% cases (9/38), ataxia in 13% (5/38) and change of level of consciousness in 34% (13/38), which was still present at the time of clinical examination in 21% (8/38) of the cases. Fever was reported in 47% (18/38) of the cases, and was also present at the time of the clinical examination in 16% (6/38) of the cases. The proportion of patients who experienced headache and seizures was 21% (8/38) and 26% (10/38), respectively. The median pedNIHSS score was 7 with scores < 5 in 13% and >15 in 11% of the cases.

Risk factors included heart disease in most cases [63% (24/38)], head injury in 18% (7/38), infections 13% (5/38) and migraine in 5% (2/38). The initial diagnostic imaging study performed to confirm the diagnosis was either CT scan [71% (27/38)], or an MRI [13% (5/38)]; in a few cases [15% (6/38)] both diagnostic procedures were used. Most children [63% (24/38)] received treatment upon diagnosis; two children were already on medication prior to diagnosis for other reasons.

The initial clinical presentation in in-hospital patients consisted of sensory-motor deficits (e.g., hemiparesis) [92% (12/13)], aphasia [23% (3/13)], ataxia [8% (1/13)], change in consciousness level [15% (2/13)], fever [38% (5/13)], and seizures [61% (8/13)]. The median pedNIHSS score was 7 with scores <5 in 15% and >15 in 8% of the cases. Risk factors reported in in-hospital patients included heart disease [69% (9/13)], head injury [8% (1/13)], and infections [23% (3/13)]. The initial diagnostic imaging performed to confirm the diagnosis were CT scans in 53% (7/13), MRI in 30% (4/13), and both diagnostic procedures in 15% (2/13) (Table 1).

Table 1. Patient characteristics and clinical data

Clinical Characteristics		**Out-of- hospital**		**In-hospital**	**Total AIS**
		N=38 (%)		**N=13 (%)**	**N=51 (%)**
Age at the time of stroke	≤ 5 years	23 (61)		11(84)	34(66)
	5.1-10 years	11(29)		1(8)	12 (24)
	10.1-15 years	4(10)		1(8)	5 (10)
Median age (years) (range)		4.2 (0.2-14.8)		2.7 (0.5-5.3)	
Gender	Male	25 (66)		8 (62)	33 (65)
	Female	13 (34)		5 (38)	18 (35)
Median pedNIHSS score		7		7	7
Clinical presentation		**Parent's report (%)**	**Clinical examination (%)**		**Total**
	Sensory-motor deficits (hemiparesis)	19(50)	33(87)	12 (92)	45 (88)
	Seizure	10(26)	1 (3)	8 (61)	9 (18)
	Change of level of consciousness	13(34)	8(21)	2 (15)	10 (20)
	Fever	18(47)	6(16)	5 (38)	11(22)
	Headache	8(21)	-	-	-
	Ataxia	5(13)	2 (5)	1(8)	3(9)
	Aphasia	9(24)	12 (32)	3 (23)	15(29)
Risk factors in child's medical history	Heart disease	24(63)		9 (69)	33 (65)
	Head injury	7(18)		1 (8)	8 (16)
	Infections	5(13)		3 (23)	8(16)
	Migraine	2(5)		0	2(4)
Initiated diagnostic imaging	CT	27 (71)		7 (53)	34(66)
	MRI	5(13)		4 (30)	9 (18)

	CT and MRI	6(15)	2 (15)	8 (16)
Treatment initiated	None	12(32)	-	12(23)
	Antithrombotic therapy	20(53)	11(85)	31(60)
	Antiplatelet therapy			
	With prior treatment	4(10)	7 (54)	11(22)
		2(5)	1(8)	3(6)

AIS=arterial ischemic stroke; PedNIHSS=Pediatric National Institute of Health Stroke, CT=computed tomography scan; MRI=magnetic resonance imaging

Table 2: Time intervals in both inpatient and outpatient cases.

	Time Intervals	**N**	**Median**	**IQR**
Out-of-hospital	Symptom onset to hospital arrival	29	10	2.8-13.2
	Symptom onset to physical assessment	33	11.7	2.1-15.6
	Symptom onset to initial neuroimaging	27	14.1	4.7-26.3
	Symptom onset to diagnosis	36	18.5	2.5-32.7
	Hospital arrival to physical assessment	32	0.20	0.15-0.40
	Hospital arrival to initial neuroimaging	29	12.1	4.8-18.3
	Hospital arrival to diagnosis	30	17.3	5.1-33.4
In-hospital	Symptom onset to physical assessment	8	.10	.1- .15
	Physical assessment to initial neuroimaging	11	4.1	3.3-18.7
	Symptom onset to diagnosis	10	5.5	2.3-20.4

Interquartile range (IQR) defined by the 25th to 75th percentile**;** N indicates number of patients with available data

3.3. Analysis of delay in diagnosis of AIS

Table 2 shows the time intervals for diagnosis of out-of-hospital patients and in-hospital patients included in the study. The median delay in diagnosis of out-of-hospital was 18.5 hours and 5.5 hours in in-hospital patients. The pre-hospital delay for out-of-hospital was 10 hours. The median delay from symptom onset to first physical assessment was 11.7 hours for out-of-hospital and 0.10 minutes for in-hospital patients. The median delay from symptom onset to initial neuroimaging was 14.1 for out-of-hospital patients and 4.1 for in-hospital patients. We found that 35% (18/51) of cases were diagnosed with AIS within the first 6 hours after the onset of symptoms;

25% (13) were diagnosed between 6–12 hours; 29% (15), between 12–24 hours; and 10% (5) were diagnosed between 24–48 hours. The majority of out-of-hospital patients (37%) were diagnosed between 12–24 hours after the onset of symptoms, while most in-hospital patients (85%) were diagnosed within the first 6 hours (Table 3). There was a significant delay in the diagnosis of out-of-hospital patients (p=0.001), time from symptom onset to first physical assessment (p=0.001), and from symptom onset to initial neuroimaging (p=0.001) compared with in-hospital patients.

Table 3: Time to diagnosis in out-of-hospital and in-hospital cases

	Time to diagnosis in hours (%)				
	< 6	**6-12**	**12-24**	**24-48**	**Total (%)**
Out-of-hospital	7 (18)	12 (32)	14 (37)	5 (13)	38(75)
In-hospital	11(85)	1(8)	1(8)	-	13 (25)
Total	18 (35)	13 (25)	15 (29)	5 (10)	51

3.4. Diagnostic management and factors contributing to delay diagnosis:

In a retrospective analysis, 42% (16) of the out-of-hospital patients received proper medical treatment; in 11 of these cases, the diagnosis was longer than 6 hours as a result of poor sensitivity of CT scan in 7 cases, delayed referral from private clinic in 2 cases, and slow response of parent's to child's symptoms in 2 cases. A 58% (22) of patients received improper medical treatment, which was related to slow response of parent's to child's symptoms in 50% of the cases. In 81% of these cases, the diagnosis was established in a period longer than 12 hours. In 4 cases (18%), the delayed diagnosis was attributed to transportation. In 1 case that was referred from a private clinic, the diagnosis was made 12 hours after symptom onset. Slow administration of procedures in the ED lead to delayed diagnosis in 6 cases (27%); in 83% of these, the diagnosis was established more than 6 hours after onset. The delay in all in-hospital patients was related to the poor sensitivity of CT scan used as an initial examination procedure (Table 4).

3.5. Factors associated with delayed diagnosis

As shown in Table 5, univariate analysis showed that younger age of the patients, lower pedNIHSS score, absence of sensory-motor deficits, absence of seizures, lack of consciousness alterations, presence of heart diseases, lower response of parents to child's condition, use of private transportation, referral from private clinics, slow administration of procedures in the ED, and lower sensitivity of CT scans are predictors of longer time to AIS diagnosis. Multivariate analysis showed that lower pedNIHSS score (p=0.002), absence of sensory-motor deficits (hemiparesis) (p=0.024), absences of seizure (p=0.046), slow parent's response to symptoms (p=0.001), transportation (p=0.001), and delayed referral from private clinics (p=0.001) were predictors of pre-hospital delay for the diagnosis of AIS. The overall prediction of the model was appropriate (F=8.6; p<0.0001; adjusted R^2=0.413). Multivariate analysis of in-hospital delays showed that lower pedNIHSS score (p=0.003),

presence of heart disease (p=0.032), and low sensitivity of scan used (CT) (p=0.0001) were predictive of longer in-hospital diagnosis delays (F=3.59; p<0.0061; adjusted R^2=0.104).

Table 4: Factors contributing to the delayed diagnosis of arterial ischemic stroke

Factors contributing to delayed diagnosis	**Time to diagnosis (hours) and diagnostic management**								N (%)
	< 6 h		**6-12 h**		**12-24 h**		**24-48 h**		
	P	**IP**	**P**	**IP**	**P**	**IP**	**P**	**IP**	
Out-of-hospital	5	2	8	4	3	11	-	5	38 (75)
• Parents		1		1		4		5	11 (50)
• Transportation		-		1		3		-	4 (18)
• Referral from private clinics		-		-		1		-	1(6)
• ED procedures		1		2		3		-	6(27)
In-hospital patients	7	4	-	1	-	1	-	-	13 (25)
• Sensitivity of scan used		4		1		1			6 (100)
Total	18		13		15		5		51

P=Proper medical management; IP= Improper medical management; ED=Emergency Department; N indicates number of patients with available data

4. Discussion

Although the number of subjects included in the study was small compared with previous studies [15, 18, 29, 30], our results showed that about two-thirds of the cases with AIS were seen by a doctor after 6 hours of symptom onset, which is consistent with the findings of other studies performed in different countries [15-18, 30]. The reasons for the delay were diverse, but they were typically related to the underestimation of the severity of the disease by the parents/caregivers and healthcare providers. In our study, for the out-of-hospital, we found that the median time taken from symptom onset to presentation to the hospital was 10 hours, and time from hospital arrival to diagnosis was 17.3 hours. For in-hospital patients, the median time from symptom onset to diagnosis was 5.5 hours. These pre-hospital and in-hospital delays were also reported in previous studies [15, 16, 18]. Gabis et al. found that the median time from symptom onset to presentation at the hospital was 24 h [16]; while the median in-hospital delay from presentation to diagnosis was 12.7 h [18]. The only study, to our knowledge, that reported shorter delays was conductedin Great Britain [17]. Most of the AIS cases included in their study were assessed by a doctor within 6 hours of symptom onset, and the diagnosis was confirmed in less than 6 hours. Their findings were attributed to the universal healthcare system enforced in Great Britain,

National Health Services (NHS), and to the fact that medical consultation expenses and imaging studies do not interfere with early diagnosis like they do in the USA [18] and Australia [15].

In our study, much of the pre-hospital delays were associated to delayed parent/caregiver response to symptoms (50%), transportations (18%), and referral from private clinics (6%).

Table 5: Univariate analysis of Factors associated with delayed diagnosis

	Pre-hospital delay		**In-hospital delay**		**Total delay**	
	N=33		**N=47**		**N=45**	
Factors	**F-value**	**P-value**	**F-value**	**P-value**	**F-value**	**P-value**
Age*		0.731		0.496		0.023
pedNIHSS score*		0.007		0.012		0.011
Sensory-motor deficits (hemiparesis)	27.86	<0.0001	32.71	<0.0001	36.61	0.001
Seizure	14.22	<0.0001	29.32	0.002	41.80	0.036
Change of level of consciousness	30.45	<0.0001	4.58	0.247	15.94	0.003
Fever	5.37	0.056	1.95	0.164	3.80	0.092
Headache	3.41	0.063	1.77	0.185	9.39	0.171
Ataxia	0.93	0.936	0.71	0.400	2.86	0.071
aphasia	16.77	0.351	1.18	0.279	1.90	0.232
Heart disease	23.14	0.005	7.46	0.007	19.36	<0.0001
Parent's response to symptoms +	29.81	<0.0001	NA	NA	6.73	0.0001
Transportation	14.27	0.001	NA	NA	15.44	0.030
Referral from private clinics	9.66	0.731	NA	NA	3.93	0.914
ED procedures	NA	NA	2.63	0.041	6.13	0.053
Sensitivity of scan used	NA	NA	30.81	<0.0001	38.64	0.005

*linear regression: Pearson correlation,+ not brought directly to ED, NA indicates Not applicable

ED=Emergency Department; PedNIHSS=Pediatric National Institute of Health Stroke

AIS symptom recognition by parents or caregivers is very challenging, as the initial symptoms can be confused with common complaints, such as headache or fatigue. The child might be unable to describe the symptoms properly. In the case of very young children, it is also difficult to assess symptoms because they have not mastered language skills yet. Symptoms might be also hard to recognize in children with developmental delay or with previous neurological impairment. It is, thus, important to raise the awareness of childhood stroke in the

general population, particularly, among parents and caregivers. Lack of awareness of stroke symptoms has been identified as a modifiable cause of delay in the diagnosis of adult stroke [31, 32].

Another contributing factor to the pre-hospital delay in AIS diagnosis observed in our study was related to transportation (18%). Unfortunately, most people in Riyadh relay on their private transportation in cases of emergencies rather than ambulances for several reasons. For instance, ambulances are mostly available at hospitals and big medical private centers; thus, requesting an ambulance involves an administrative process, which can be lengthy at times, leading to a low response time. In the case of private centers, such specialized transportation services are costly. Other reasons are related to traffic congestion, bad roads, road closures, or detours in some areas.

Delayed referrals from private clinics, occur in 6% of the cases; however, our analysis did not show a significant effect of such factors on the delayed diagnosis of AIS, which was probably related to the small number of subjects included in this study.

In our study, the in-hospital delay in the diagnosis of AIS was 5.5 hours, which can be largely related to the lack of awareness of stroke among healthcare providers. It has been documented that clinical suspicion of AIS is often low among healthcare providers. After the initial assessment, AIS was reported in only 38% of the children [18] in one study and in 26% [15] in another study. In the later study, 86% of the patients had focal neurological deficits and 58% were admitted to the hospital at the time of their symptom onset. The median time to diagnosis, however, was more than 24 hours for children and more than 87 hours in neonates [15].

Because AIS occurs infrequently, healthcare providers may overlook AIS in children. Population-based estimates of the incidence of pediatric AIS range from 2 to 5 per 100,000 children/year [2, 11]. Another reason is related to the broad differential diagnosis for many of the non-focal presentation symptoms of childhood stroke, such as hemiparesis, seizures, and headache. Braun et al.(2006) found that a significant percentage of the patients who were misdiagnosed had hemiparesis or aphasia from AIS that was attributed to a post-ictal state [23].

Another reason for the delay in diagnosis once the patient is at hospital is the low sensitivity of cranial ultrasonography and CT scans compared with MRI [15, 17]. Even though a CT scan is performed within 6 hours of stroke symptom onset, some studies reported that CT scan do not contribute to the diagnosis of AIS in the majority of pediatric patients (52-84%) [18, 22, 33]. Even so, in a few cases, MRI is used to confirm the diagnosis [15]. However, the request for MRI are typically fulfilled after long periods of time in the majority of children; in some cases, it may even take as long as 24 hours or more [17, 18]. Such a delay is attributed to high sensitivity of MRI, which requires individuals to undergo complete sedation or anesthesia.

Long ED procedures (27%) were also identified as a significant contributing factor to in-hospital delay. Several studies from different countries [34-39], including Saudi Arabia [40], have looked at the causes of patients treatment delay at the ED and reported the following: ED overcrowding [34-36], multiple consultations with further investigations advised [35, 36, 39, 40], multiple assessment in different ED areas [35, 36, 39, 40], late

arrival of investigations reports [35, 36], file making process [40], patients' personal and economic constraints [40] and over utilized and inappropriately staffed ED [38]. Because of the nature of the current study and lack of prospective data, the causes related to lengthy ED procedures and time spent at the ED were not investigated; however, this factor should be considered in future studies.

The predicted delay of AIS in-hospital diagnosis as a result of lower pedNIHS score in association with other factors such as absence of sensory-motor deficits, absence of seizures, lack of altered of consciousness, and presence of heart disease was consistent with other studies from different countries [15, 18]. These finding signals the importance of increasing awareness of AIS symptoms to reduce the time lag to diagnosis.

4.1. Future work

Although our study included a small sample size and only evaluated cases managed at one site, the results clearly show a delay in the diagnosis of pediatric AIS as a result of inpatient and outpatient factors. Therefore, because of the relevance of this issue, a multicenter study with a larger sample size, including different regions in Saudi Arabia would allow the integration of several factors in an explanatory model simultaneously.

The results of our study and previous studies signal a huge need for large-scale educational programs regarding the early signs and symptoms of pediatric AIS, consequences, benefits of early and optimal management, and treatment options targeted to the general population as well as medical professionals, particularly for those exposed to high-risk groups such as children with heart disease.

4.2. Limitations

The study was performed retrospectively; therefore, we were unable to determine accurate timing of specific events from medical records, such as onset of the first stroke symptoms, the first neuroimaging studies obtained, and timing of referral from private clinics. Delay to AIS diagnosis could not be used as a continuous variable,instead four broad time windows were used. Other limitations to our study are that the study population was composed of patients from hospital single center that services mostly nearby areas, and could represent less demographic variations between subjects and their caregivers. Therefore, the results are not entirely applicable to the general population. The relatively small sample size is also considered as a limiting factor, as it meant that only a limited number of factors influencing time to clinical diagnosis could be evaluated.

5. Conclusions

The results of this study clearly indicate a delay in AIS diagnosis, which must be addressed by increasing awareness to predisposing conditions and recognition of AIS symptoms among medical professionals that will allow children to benefit from acute medical interventions that have been shown to improve outcomes in the adult population. Increased awareness should also be extended to general public, particularly parents and other caregivers, regarding stroke in general and AIS in particular, including information on causes, pain, costs, practical problems, benefits of early management, and current treatment options. These interventions are

important because lack of awareness has been identified as a modifiable cause of delay in the diagnosis of adult stroke [31, 32].

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